A New Time Resolved Experiment for the Microscopic Study of Magnetization Dynamics Using X-PEEM

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Obtaining a microscopic understanding of the dynamics of magnetization reversal process is of principal importance for high-density magnetic data storage, e.g. on hard disk media and in novel magnetic random access memory devices (MRAM). Phenomena that appear on a ps to ns time scale are magnetization precession, magnetization damping, thermal fluctuations, spin waves and magneto-static modes. New schemes of ultra-fast manipulation of the magnetization can be devised based on the availability of fast pulses, e.g. utilizing the precession of the magnetization in an applied field pulse or pulsed injection of a spin polarized current into a ferromagnet. Study of these phenomena requires in addition to ps time resolution a very high spatial resolution and sensitivity because of the small size of the switching volume. X-ray PEEM offers high spatial resolution in addition to good chemical and magnetic sensitivity and is therefore well adapted to the investigation of magnetic phenomena on a nano-scale. We are currently designing a synchronized f-sec laser – synchrotron PEEM experiment, which will in its final version allow magnetization dynamics studies with 50 ps time and <5 nm spatial resolution. The test system that is currently set up at the Advanced Light Source has a more moderate spatial resolution of <100 nm. The setup includes a 125 MHz Ti:sapphire laser which is synchronized to the repetition rate of the Advanced Light Source. The laser is used to either stroboscopically excite the sample or to trigger a photoconductive switch driving a current through a coil or directly through the magnetic device. The evolution of the magnetization can then be followed as function of the delay between the laser pump and x-ray probe pulse which has a length of approximately 50 ps. Future f-sec x-ray sources could extend the time resolution of such an experiment into the sub-ps regime.